

PHOTOMULTIPLIER

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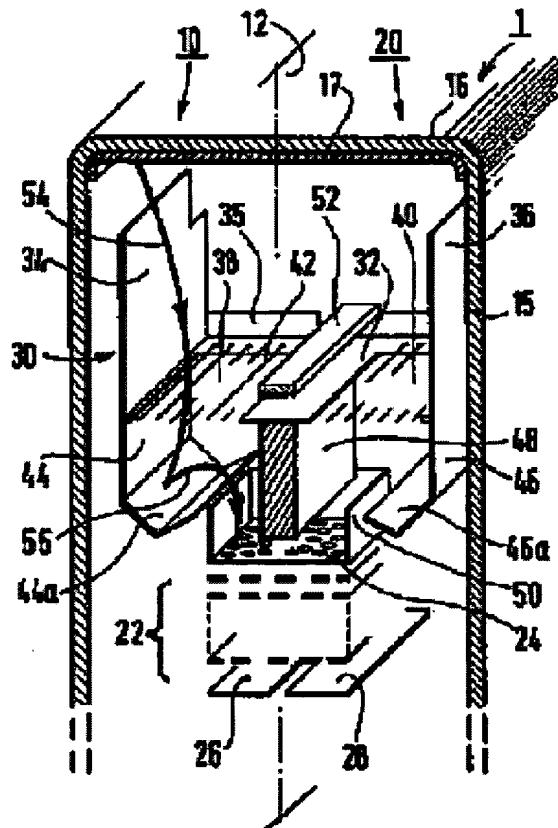
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Abstract of JP7192686

PURPOSE: To provide a photomultiplier with improved photoelectron collecting efficiency.

CONSTITUTION: In a photomultiplier 1, upper parts 34, 35, 36 of an electrode 30 work as a focusing electrode to distribute photoelectrons to both sides of an axial face 12, and lower parts 44, 44a, 46, 46a form a collector part. The initial multiplication of photoelectrons is carried out in the parts 44a, 46a, which are curved toward the axial face direction, of the walls 44, 46 facing to the side face. Hole parts 38, 40 of a middle flat plate 32 of the electrode 30 are covered with a highly transmissive grid 42. The electrode is further provided with a center partitioning wall 48 spread near to an input diode 24 of the thin layer electron multiplier from the flat plate 32. A transverse rod 52 having a small cross section exists on the axial face 12 and a potential near the potential to the photoelectric cathode is applied to the rod.



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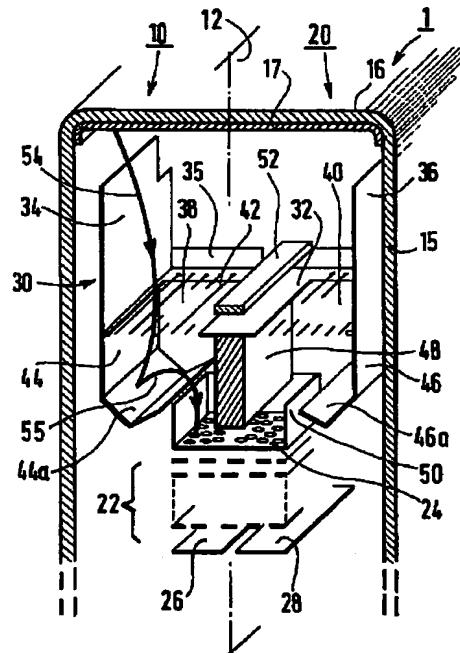
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(54)【発明の名称】 光電子増倍管

(57)【要約】

【目的】 光電子の収集効率を改善した光電子増倍管を提供する。

【構成】 光電子増倍管1では、電極30の上部部分34,35,36が軸面12の両側に光電子を分布させるフォーカス電極として作用し、下部部分44,44a,46,46aがコレクタ部分を形成する。光電子の最初の増倍は側面に向いた壁4,46の軸面方向に折れ曲がった部分44a,46aで行われる。電極30の中間平板32の孔部38,40は透過性の高いグリッド42によって覆われる。電極30は更に平板32から薄層電子増倍器の入力ダイノード24の近くまで拡がる中央隔壁48を具える。小さい断面を持つ横棒52が軸面12上にあり、光電陰極の電位に近い電位を与えられる。



【特許請求の範囲】

【請求項1】少なくとも2つの増倍経路を有し、密閉され前面の内側表面に光電陰極を具えたエンベロープを有し、光電陰極から離れて位置して増倍経路の1つにある光電子をそれらの光電陰極からの射出位置によって分割を行う電子光学手段を有し、更に、少なくとも1つの入力ダイノードを有する分割型電子増倍器を持つ分割型の光電子増倍管において、該電子光学手段が光電陰極から遠ざかる方向に2つの連続した部分即ちフォーカス部分及びコレクタ部分を含む電極を具え、該2つの部分は軸面の両側に配置された少なくとも2つの孔部を持つ中間平板によって分けられ、それらのそれぞれの孔部は透過性の高いグリッドによって覆われ、該フォーカス部分は軸面に面し光電陰極の方向に向いた2つのエッジを持ち、該コレクタ部分は軸面に面し側面に向いた2つのエッジを持ち、その2つの側面に向いた2つのエッジはそれぞれ軸面の方向に折れ曲がっており、これによって光電子の1次増倍が行われる面を形成し、更に、該コレクタ部分が、実質的に中央の軸面上に位置し前記中間平板から光電陰極と逆の方向に伸びている隔壁を具えたことを特徴とする光電子増倍管。

【請求項2】前記電子光学手段が、更に、軸面に関して実質的に中央に位置する横棒を具え、該横棒は電極の前記フォーカス部分に前記中間平板に平行に該中間平板と電気的に絶縁されて配置され、該横棒は光電陰極の電位に近い電位を持つように構成されたことを特徴とする請求項1に記載の光電子増倍管。

【請求項3】前記電子増倍器の入力ダイノードのエッジが、軸面に面し、上の方向に向き、少なくとも前記折れ曲がり部分の下部の位置まで入り込むように構成されたことを特徴とする請求項1又は2に記載の光電子増倍管。

【請求項4】電極の前記フォーカス部分が軸面に面し上向き以外のエッジを持ち、該エッジの光電陰極の方向の高さが前記上向きエッジの高さより低いことを特徴とする請求項1乃至3のいずれか1項に記載の光電子増倍管。

【請求項5】4つの増倍経路があり、小さい断面積を持つ同様のもう1つの横棒が電極のフォーカス部分の中央に具えられ、この横棒は軸面に垂直で中間平板に平行で中間平板と電気的に絶縁され、2つの横棒が電気的に相互接続され、且つ、電極が、更に、軸面に垂直に配置され実質的に電極の中央に位置し中間平板から光電陰極と逆の方向に伸びているもう1つの隔壁を具えたことを特徴とする請求項2又は3に記載の光電子増倍管。

【請求項6】前記横棒が長方形の断面を有するストリップ形状であることを特徴とする請求項2乃至5のいずれか1項に記載の光電子増倍管。

【請求項7】前記横棒が、長さ方向に沿って折り曲げ

られ即ちV字形断面を形成しV字形の折り曲げ基部が光電陰極の方向に向いているストリップからなることを特徴とする請求項1乃至5のいずれか1項に記載の光電子増倍管。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、少なくとも2つの増倍経路を有し、密閉され前面の内側表面に光電陰極を具えたエンベロープを有し、光電陰極から離れて位置して増倍経路の1つにある光電子をそれらの光電陰極からの射出位置によって分割を行う電子光学手段を有し、更に、少なくとも1つの入力ダイノードを有する分割型電子増倍器を持つ分割型の光電子増倍管に関するものである。

【0002】

【従来の技術】この種の光電子増倍管は欧州特許公報EP-A-428215に開示されている。この公報は、増倍経路の数がそれほど多くなく、簡単で安価な光電子増倍管を特別な目的としたものである。この型の光電子増倍管の主な用途は、局部的な光の空間において位置を定めるための接触モザイク装置に利用することである。主な場合、これらの光は各増倍管の前面に位置する発光体から発する。分割型光電子増倍管（即ち多経路管）が更に安価になれば、この型の光電子増倍管が通常の管に代わってこのような用途にもっと経済的に利用されることになる。更に、基本的な分割管の光電子増倍管が小型で、使用される分割型の管が管毎に及び増倍経路毎に可能な限り均一な性能を持つならば、光学的事象がもっと精度よく位置決めできる。考慮すべきもう1つの点は、同一管の増倍経路間の光の横漏れを可能な限り小さくすることである。

【0003】前記の公報に開示された分割型増倍管は、基本的な部分が全ての経路に共通である電子光学手段により、光電陰極から射出する位置に基づいて異なる経路をとる電子の分布を規定し、期待される構造的な簡潔さを或る程度満足したものになっている。

【0004】

【発明が解決しようとする課題】本発明の目的は、既知のものを改良した光電子増倍管を提供することにあり、特に、光電子の収集効率を改善した光電子増倍管を提供することにある。本発明は、最良の収集効率を持たない薄層増倍装置の入力ダイノードに光電子を導入することはせず、固体構造のダイノードによって最初の増倍を行い、その後2次電子を電子増倍器に導入するという創意に基づいている。よく知られているように、最初のダイノードは光電子増倍管の特性の大部分を決定する。

【0005】

【課題を解決するための手段】この目的を達成するため、本発明の分割型光電子増倍管は、前記の電子光学手段が光電陰極から遠ざかる方向に2つの連続した部分即ちフォーカス部分及びコレクタ部分を含む電極を具え、

この2つの部分は軸面の両側に配置された少なくとも2つの孔部を持つ中間平板によって分けられ、それらのそれぞれの孔部は透過性の高いグリッドによって覆われ、このフォーカス部分は軸面に面し光電陰極の方向に向いた2つのエッジを持ち、このコレクタ部分は軸面に面し側面に向いた2つのエッジを持ち、その2つの側面に向いた2つのエッジはそれぞれ軸面の方向に折れ曲がっており、これによって光電子の1次増倍が行われる面を形成し、更に、このコレクタ部分が、実質的に中央の軸面上に位置し前記中間平板から光電陰極と逆の方向に伸びている隔壁を具えたことを特徴とする。

【0006】本発明の光電子増倍管においては、光電陰極によって射出される電子は、それらの射出位置に基づいて適切な電界によって電子的に軸面の両側に分けられる。その結果、光電子増倍管は簡単な構造になる。この増倍管のコレクタ部分の折れ曲がり部分における最初の増倍の後、2次電子は電子増倍器の入力ダイノードに印加される電圧に応答してこのコレクタ部分に広がる抽出電界の作用のみに従うので、この増倍管は良好な収集効率を持つという利点を有する。この電圧は実際に電極に印加される電圧より高い。最初の増倍が行われる表面は、これらの2次電子の一部をこの同じ表面に押し戻すような後引電界を受けることはない。

【0007】本発明の有利な実施例によれば、光電子増倍管の前記電子光学手段が、更に、軸面に関して実質的に中央に位置する横棒を具え、この横棒は電極のフォーカス部分に前記中間平板に平行にこの中間平板と電気的に絶縁されて配置され、この横棒は光電陰極の電位に近い電位を持つように構成される。このような配置は光電子がコレクタ部分の折れ曲がり部分に正確に集中するために好都合である。

【0008】好ましくは、電子増倍器の前記入力ダイノードのエッジが、軸面に面し、上の方向に向き、少なくとも前記折れ曲がり部分の下部の位置まで入り込むように構成される。これにより、最初の増倍の後の電子の抽出とこれらの電子の増倍器の入力ダイノード上への集中を最良にする。本発明は、管の軸面の両側に例えば対称的に配置された増倍経路を持つ光電子増倍管を得るために利用することができる。

【0009】本発明は更に4経路増倍管を提供することを目的とし、この増倍管は、小さい断面積を持つ同様のもう1つの横棒が電極のフォーカス部分の中央に具えられ、この横棒は軸面に垂直で中間平板に平行で中間平板と電気的に絶縁され、2つの横棒が電気的に相互接続され、且つ、電極が、更に、軸面に垂直に配置され実質的に電極の中央に位置し中間平板から光電陰極と逆の方向に伸びているもう1つの隔壁を具えている。

【0010】本発明のこの実施例によれば、光電子増倍管が軸面に対して対称になり、その各々の側に2つの基本増倍器が具えられ、実質的に十文字型になっている小

さい断面の横棒の複合作用によって基本的に広がった適切な電界の作用により、その両者が陰極からの射出位置に従って電子を受ける。

【0011】

【実施例】次に、図面を用いて実施例を詳細に説明する。図1は本発明による光電子増倍管の第1の実施例の部分の断面図である。光電子増倍管1は、軸面12に関して対称に配置された2つの基本的な光電子増倍器10及び20を具えている。それは、前面16を有し、その内側表面に光電陰極17が配置されている密封型のエンベロープ15を含む。この光電子増倍管は更に貫通孔を有する板状の電子増倍器22を含む。この電子増倍器22は軸面12に関して2つの対称の部分に分割され、入力ダイノード24及び2つの陽極26と28が配されている。

【0012】本発明によれば、電子光学手段が、光電陰極からの光電子の射出位置に従ってそれぞの増倍経路即ち、図では軸面12の左側か右側かに光電子を分ける。この電子光学手段は、この例では四角形の平板32を具えた電極30から構成され、この電極は平板32の2つのエッジのそれぞれに沿った壁面34及び36を有し、この壁面は軸面12に平行に拡がり、光電陰極17の方向に立ち上がっている。この平板32は、第1の部分即ちフォーカス部分に、軸面12の両側に位置しそれぞれが高い透過性を有するグリッド42に覆われている2つの孔部38及び40を持つ。図に示すように、このグリッドは、電子の通過に対する妨害が無視できるように平板32の辺から他の辺に張られた細線によって形成することができる。

【0013】電極30は第2の部分、即ちコレクタ部分を含む。このコレクタ部分は軸面12に面し側面に向いたエッジ44及び46を含み、それぞの折れ曲がり部分44a及び46aが軸面に向かって延びており、これが光電子の1次の増倍を実現するように構成されている。

【0014】コレクタ部分即ち平板32に関して電極の下部部分は、更に、軸面12に位置し平板32から光電陰極17と逆の方向に拡がっている中央隔壁48を含む。この中央隔壁48の端部は電子増倍器22の入力ダイノード24の近くに位置している。入力ダイノード24は光電陰極17の方向に立ち上がっている2つのエッジ50を有する。この2つのエッジは好ましくは少なくとも前記の折れ曲がり部分44a及び46aの下部の位置まで入り込むように構成される。

【0015】電子光学手段は最後に横棒52を具えて完全なものになる。この横棒52はここではその長さに比較して小さい断面を持つ薄いトリップであり、軸面12上の中央部分に平板32に平行に且つこの平板32と僅かに離れて位置する。横棒52は、電極30と電気的に絶縁され且つ光電陰極17と等しいか又はそれに近い電位を与えられる。

【0016】このような電子光学手段は、2つの基本的な光電子増倍器10及び20の全面に光電子を分布させるよ

うにする。図に最初の1つの増倍経路が線54によって表示されているように、最初の増倍は側面に向いたエッジ44及び46の折れ曲がり部分44a及び46aで主として行われる。平板32の下に設けられた空間には電子増倍器22の入力ダイノード24によって得られる電界のみが存在し、入力ダイノード24は電極30の電位より高い電位を与える。ダイノード24と電極30との間の電位差は例えば100Vである。このような抽出電界は、折れ曲がり部分44a及び46aでの増倍の後2次電子を飛び出させるために作り出され、この電界は中央隔壁48により2次電子が増倍器22の入力ダイノード24に向かうように作用する。2次電子の経路は線55で表示されている。

【0017】この型の分割型光電子増倍管は、最初の増倍が固体構造のダイノードにおいて増倍効率が最大になるようにして行われるので、従来の光電子増倍管に比較して良好な収集効率を有する。よく知られているように、最初の増倍が光電子増倍管において主要な役割を持っている。

【0018】図2は本発明の他の実施例である分割型4経路光電子増倍管を示す図である。この図においては、管の電子光学手段に関する部分、即ち基本的な4つの経路に光電子を分布させる部分のみを示している。図1の実施例に示したものと同一の機能を有する部分には可能な限り同一の参照番号を付している。

【0019】図示された電極60は、四角形の平板32を具え、軸面12に平行に延び光電陰極の方向に立ち上がっている2つのエッジ34、36を持つフォーカス部分を有する。平板32は、軸面12に関して対称的に2行2列に位置した4つの孔部38、39、40及び41を有する。軸面12の同じ側の孔部38及び39、又は40及び41が、平板32から光電陰極と逆の方向即ち図の下方に拡がっているもう一つの隔壁49によって隔てられている。このもう一つの隔壁49は電極60の中央部分に位置し、図1に示されているような型の最初の隔壁48と共に、光電子が全面に分布している独立の4つの経路が生じる空間を形成している。更にここでは、各孔部38-41が、例えば平板32の面内で張られた細線42から形成された高い透過性を有するグリッドによって覆われている。

【0020】電極60は、ここではコレクタ部分と称する、平板32のレベルより下に位置する部分を有する。この部分は軸面12に面し側面に向いたエッジ44及び46を持つ。このエッジ44及び46の端部はそれぞれ軸面12の方向に折れ曲がっている折れ曲がり部分44a及び46aを含む。更に、ここではこれらの折れ曲がり部分が光電子の最初の増倍を実現する表面になる。従ってこれらは光電子増倍管の最初のダイノードとして作用する。

【0021】図1の実施例に示したように、小さい断面の横棒52が平板32の近くに且つ軸面12上に配置される。この横棒は光電陰極の電位に近い電位を与えられる。従って、この横棒52は軸面12の両側において光電子の分布

を規定するための適切な電界を得るのに役立っている。同様に、もう一つの横棒53は、横棒52と同じく電極60の中間点に位置するが但し軸面12に垂直になっている。横棒52及び53は電気的に接続されている。この横棒53は、平板32と僅かに離れてこれと絶縁されてこれに平行に位置している。この横棒53は、軸面12に平行な電界の分布を生成し、光電子が光電陰極から射出する際の位置に従って孔部38又は39のいずれかに光電子が分布するようになる作用を有する。このもう一つの横棒53は、光電子が光電陰極から射出する際の位置に従って孔部40又は41のいずれかに光電子が分布するようになる作用を有する。

【0022】図1及び図2の実施例に示したように、電極の平板32も軸面12に垂直に位置するエッジ35を有する。これらのエッジは上向きエッジ34、36の高さより低い高さを持つ。従って、軸面12の両側全面に光電子を分布させるのに適当な電界を実現する。

【0023】前記の実施例では、横棒は平らなストリップとして説明したが、他の形状であってもよい。例えば、図3に52aとして示したように、長さ方向に沿ってV字形に折り曲げられ、その基部が光電陰極の方向を指すように位置するものであってもよい。

【0024】本発明の特徴の他の変更が当業者にとって容易であり、これらの変更は本発明の範囲に含まれる。

【図面の簡単な説明】

【図1】図1は、本発明による光電子増倍管の第1の実施例の部分断面図である。

【図2】図2は、本発明の他の実施例である分割型4経路光電子増倍管を示す透視図である。

【図3】図3は、本発明で用いられる横棒の一変形を示す透視図である。

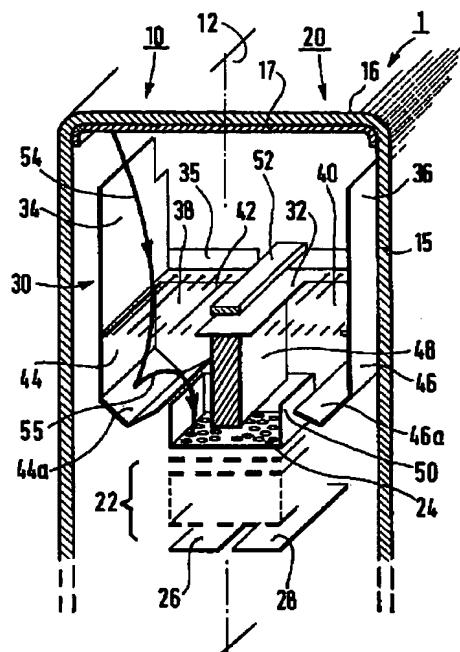
【符号の説明】

- 1 光電子増倍管
- 10、20 光電子増倍器
- 12 軸面
- 15 密封型のエンベロープ
- 16 密封型のエンベロープの前面
- 17 光電陰極
- 22 電子増倍器
- 24 ダイノード
- 26、28 陽極
- 30、60 電極
- 32 平板
- 34、36 壁面
- 38、39、40、41 孔部
- 42 グリッド
- 44、46 側面に向いたエッジ
- 44a、46a 折れ曲がり部分
- 48 中央隔壁
- 49 もう一つの隔壁
- 50 立ち上がりエッジ

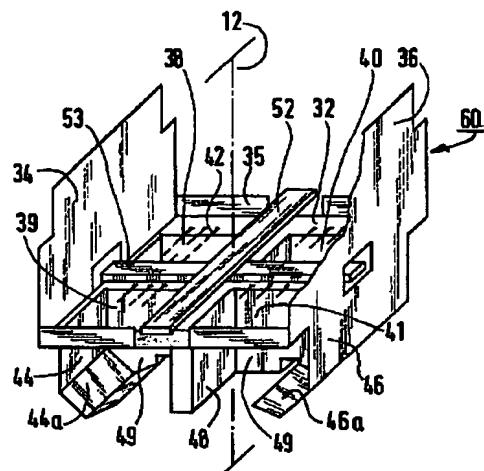
52、52a 横棒
53 もう一つの横棒

* 54 最初の1つの増倍経路
* 55 2次電子の経路

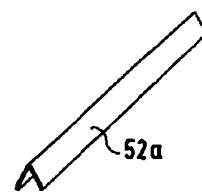
【図1】



【図2】



【図3】



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CLAIMS

[Claim(s)]

[Claim 1] It has the envelope which had at least two multiplication paths, was sealed and equipped the front inside front face with photoelectric cathode. It has a electron optics means by which the shot position from those photoelectric cathode divides the photoelectron which is separated and located from photoelectric cathode and is in one of the multiplication paths. Furthermore, it sets to the photomultiplier tube of an assembled die with the assembled-die electron multiplier which has at least one input dynode. It has an electrode containing two continuous parts, i.e., focal part, and collector parts in the direction in which this electron optics means keeps away from photoelectric cathode. Two parts are divided by the middle plate with at least two pores arranged at the both sides of an axial plane. this -- Each of those pore is covered with a penetrable high grid, and this focal part has two edges which faced the axial plane and were suitable in the direction of photoelectric cathode. This collector part had two edges which faced the axial plane and turned to the side face, and two edges suitable for the two side faces have bent in the direction of an axial plane, respectively. The photomultiplier tube characterized by having the septum which the field where primary multiplication of a photoelectron is performed was formed, and this collector part was substantially located further on the central axial plane, and has been extended in the direction contrary to photoelectric cathode from said middle plate by this.

[Claim 2] It is the photomultiplier tube according to claim 1 which said electron optics means is further equipped with the bar substantially located in the center about an axial plane, said focal part of an electrode insulates with this middle plate electrically, and this bar is arranged in parallel on said middle plate at it, and is characterized by constituting this bar so that it may have the potential near the potential of photoelectric cathode.

[Claim 3] The photomultiplier tube according to claim 1 or 2 characterized by constituting the edge of the input dynode of said electron multiplier so that an axial plane may be faced and it may enter to the location of the lower part of said bending part at least toward the direction of [upper].

[Claim 4] The photomultiplier tube given in claim 1 which said focal part of an electrode faces an axial plane, has edges other than facing up, and is characterized by the height of the direction of the photoelectric cathode of this edge being lower than the height of said upward edge thru/or any 1 term of 3.

[Claim 5] There are four multiplication paths and it has another same bar with the small cross section in the center of the focal part of an electrode. This bar is perpendicular to an axial plane, is parallel to a middle plate, and is electrically insulated with a middle plate. The photomultiplier tube according to claim 2 or 3 characterized by having another septum which two bars interconnected electrically, and the electrode has been further arranged at right angles to an axial plane, was substantially located in the center of an electrode, and has been extended in the direction contrary to photoelectric cathode from the middle plate.

[Claim 6] The photomultiplier tube given in claim 2 characterized by said bar being the strip configuration which has a rectangular cross section thru/or any 1 term of 5.

[Claim 7] The photomultiplier tube given in claim 1 characterized by consisting of a strip by which said

bar was bent along the die-length direction, namely, formed V typeface cross section, and the bending base of V typeface is suitable in the direction of photoelectric cathode thru/or any 1 term of 5.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention has the envelope which had at least two multiplication paths, was sealed and equipped the front inside front face with photoelectric cathode, has a electron optics means by which the shot position from those photoelectric cathode divides the photoelectron which is separated and located from photoelectric cathode and is in one of the multiplication paths, and relates to the photomultiplier tube of an assembled die with the assembled-die electron multiplier which has at least one input dynode further.

[0002]

[Description of the Prior Art] This kind of photomultiplier tube is Europe patent official report EP-A - 428215. It is indicated. This official report sets the photomultiplier tube with so many easy and cheap number of multiplication paths as the special purpose. The main applications of this type of photomultiplier tube are using for the contact mosaic equipment for defining a location in the space of a local light. When main, such light is emitted from the emitter located in the front face of each intensifier. If the assembled-die photomultiplier tube (namely, multi-path tubing) becomes still cheaper, this type of photomultiplier tube will be more economically used for such an application instead of the usual tubing. Furthermore, the photomultiplier tube of fundamental division tubing is small, and if tubing of the assembled die used reaches for every tubing and has the most uniform possible engine performance for every multiplication path, an optical event can position with a more sufficient precision. Another point which should be taken into consideration is making the horizontal leakage of the light between the multiplication paths of the same tubing as small as possible.

[0003] The assembled-die intensifier indicated by the aforementioned official report specifies distribution of the electron which takes the path from which a fundamental part differs with a electron optics means common to all paths based on the location injected from photoelectric cathode, and has become a certain thing which carried out extent satisfaction about the structural conciseness expected.

[0004]

[Problem(s) to be Solved by the Invention] The purpose of this invention is to offer the photomultiplier tube which improved the known thing, and is to offer the photomultiplier tube which has improved the collector efficiency of a photoelectron especially. It does not carry out that this invention introduces a photoelectron into the input dynode of thin layer multiplication equipment without the best collector efficiency, but it performs the first multiplication by the dynode of solid structure, and is based on the original idea of introducing a secondary electron into an electron multiplier after that. The first dynode determines most properties of the photomultiplier tube as known well.

[0005]

[Means for Solving the Problem] In order to attain this purpose, the assembled-die photomultiplier tube of this invention It has an electrode containing two continuous parts, i.e., focal part, and collector parts in the direction in which the aforementioned electron optics means keeps away from photoelectric cathode. These two parts are divided by the middle plate with at least two pores arranged at the both

sides of an axial plane. Each of those pore is covered with a penetrable high grid, and this focal part has two edges which faced the axial plane and were suitable in the direction of photoelectric cathode. This collector part had two edges which faced the axial plane and turned to the side face, and two edges suitable for those two side faces have bent in the direction of an axial plane, respectively. The field where primary multiplication of a photoelectron is performed by this is formed, and it is further characterized by equipping this collector part with the septum which was substantially located on the central axial plane and has been extended in the direction contrary to photoelectric cathode from said middle plate.

[0006] In the photomultiplier tube of this invention, the electron injected by photoelectric cathode is electronically divided into the both sides of an axial plane by suitable electric field based on those shot positions. Consequently, the photomultiplier tube becomes easy structure. After the first multiplication in the bending part of the collector part of this intensifier, since a secondary electron follows only an operation of the extract electric field which answer the electrical potential difference impressed to the input dynode of an electron multiplier, and spread into this collector part, this intensifier has the advantage of having good collector efficiency. This electrical potential difference is higher than the electrical potential difference actually impressed to an electrode. The front face where the first multiplication is performed does not receive ******, after putting back a part of these secondary electrons to this same front face.

[0007] It is constituted so that may have the bar with which said electron optics means of the photomultiplier tube is substantially located in the center according to the example advantageous [of this invention], concerning an axial plane further, this bar may be insulated as electrically in parallel as this middle plate by the focus part of an electrode at said middle plate, it may be arranged and it may have potential with this bar near the potential of photoelectric cathode. Such arrangement is convenient in order that a photoelectron may focus on the bending part of a collector part correctly.

[0008] Preferably, the edge of said input dynode of an electron multiplier faces an axial plane, and toward the direction of [upper], it is constituted so that it may enter to the location of the lower part of said bending part at least. Thereby, extract of the electron after the first multiplication and concentration of a up to [the input dynode of the multiplication machine of these electrons] are made best. This invention can be used in order to obtain the photomultiplier tube with the multiplication path arranged for example, on the symmetry target at the both sides of the axial plane of tubing.

[0009] It aims at offering 4 path intensifier. this invention -- further -- this intensifier It has another same bar with the small cross section in the center of the focal part of an electrode. It has another [which this bar was perpendicular to the axial plane, and it was parallel to the middle plate, and insulated as electrically as a middle plate, and two bars interconnected electrically, and the electrode has been arranged still at right angles to an axial plane, was substantially located in the center of an electrode, and has been extended in the direction contrary to a middle plate to photoelectric cathode] septum.

[0010] according to this example of this invention, the photomultiplier tube becomes the symmetry to an axial plane, that each side is equipped with two basic multiplication machines, and those both receive an electron according to the shot position from cathode according to an operation of the suitable electric field which spread fundamentally according to a compound operation of the bar of the small cross section which is a cross mold substantially.

[0011]

[Example] Next, an example is explained to a detail using a drawing. Drawing 1 is the sectional view of the part of the 1st example of the photomultiplier tube by this invention. The photomultiplier tube 1 is equipped with two fundamental photoelectron multiplication machines 10 and 20 arranged about an axial plane 12 at the symmetry. It has a front face 16 and contains the envelope 15 of the seal mold with which photoelectric cathode 17 is arranged on the inside front face. This photomultiplier tube contains the tabular electron multiplier 22 which has a through tube further. This electron multiplier 22 is divided into the part of two symmetry about an axial plane 12, and the input dynode 24 and two anode plates 26 and 28 are allotted.

[0012] According to this invention, a electron optics means divides a photoelectron into the left-hand

side or right-hand side of an axial plane 12 according to the shot position of the photoelectron from photoelectric cathode, each multiplication path, i.e., drawing. This electron optics means consists of electrodes 30 equipped with the plate 32 of ***** in this example, this electrode had the wall surfaces 34 and 36 in alignment with each of two edges of a plate 32, and this wall surface spread in parallel with an axial plane 12, and it has started in the direction of photoelectric cathode 17. This plate 32 has two pores 38 and 40 covered with the grid 42 to which it is located in the both sides of an axial plane 12, and each has high permeability, the 1st part, i.e., focal part. As shown in drawing, this grid can be formed with the thin line stretched from the side of a plate 32 in other sides so that the active jamming over passage of an electron could be disregarded.

[0013] An electrode 30 contains, the 2nd part, i.e., collector part. This collector part contains the edges 44 and 46 which faced the axial plane 12 and turned to the side face, and is each bending partial 44a. And 46a It has extended toward the axial plane, and it is constituted so that this may realize primary multiplication of a photoelectron.

[0014] The lower part of an electrode contains further the central septum 48 which was located in the axial plane 12 and has spread in the direction contrary to photoelectric cathode 17 from the plate 32 about the collector part 32, i.e., a plate. The edge of this central septum 48 is located near the input dynode 24 of an electron multiplier 22. The input dynode 24 has two edges 50 which have started in the direction of photoelectric cathode 17. These two edges are the aforementioned bending partial 44a desirable at least. And 46a It is constituted so that it may enter to a lower location.

[0015] A electron optics means will become perfect in preparation for the last about a bar 52. This bar 52 is a thin strip which has a small cross section as compared with that die length, separates on a plate 32 as slightly in parallel as this plate 32, and is located in the central part on an axial plane 12 here. It insulates with an electrode 30 electrically, and a bar 52 is equal to photoelectric cathode 17, or can give the potential near it.

[0016] It is made for such a electron optics means to distribute a photoelectron all over two fundamental photoelectron multiplication machines 10 and 20. It is bending partial 44a of the edges 44 and 46 with which the first multiplication turned to the side face as the first one multiplication path was displayed on drawing by the line 54. And 46a It is mainly carried out. Only the electric field acquired by the input dynode 24 of an electron multiplier 22 exist in the space established in the bottom of a plate 32, and the input dynode 24 gives potential higher than the potential of an electrode 30. The potential difference between a dynode 24 and an electrode 30 is 100V. Such extract electric field are bending partial 44a. And 46a It is made in order to make the back secondary electron of multiplication jump out, and this electric field act so that a secondary electron may go to the input dynode 24 of the multiplication machine 22 by the central septum 48. The path of a secondary electron is expressed as the line 55.

[0017] Since the first multiplication is performed as multiplication effectiveness becomes max in the dynode of solid structure, this type of assembled-die photomultiplier tube has good collector efficiency as compared with the conventional photomultiplier tube. The first multiplication has main roles in the photomultiplier tube as known well.

[0018] Drawing 2 is drawing showing the assembled-die 4 path photomultiplier tube which are other examples of this invention. In this drawing, the part about the electron optics means of tubing, i.e., the part which distributes a photoelectron over four fundamental paths, is shown. The same possible reference number is given to the part which has the same function as what was shown in the example of drawing 1 .

[0019] The illustrated electrode 60 is equipped with the square plate 32, and has two edges 34 which were prolonged in parallel with an axial plane 12, and have started in the direction of photoelectric cathode, and a focal part with 36. A plate 32 has four pores 38 symmetrically located in two-line two trains about the axial plane 12, 39, and 40 and 41. The pores 38 and 39 of the same side of an axial plane 12, or 40 and 41 are separated from the plate 32 by another septum 49 by which the direction contrary to photoelectric cathode, i.e., drawing, spreads out caudad. This septum 49 of another is located in the central part of an electrode 60, and forms the space which four independent paths in which the photoelectron is distributed over the whole surface with the septum 48 of the beginning of a mold as

shown in drawing 1 produce. Furthermore, each pore 38-41 is covered with the grid which has the high permeability formed from the thin line 42 stretched in the field of a plate 32 here.

[0020] An electrode 60 has the part located below the level of a plate 32 called a collector part here. This part has the edges 44 and 46 which faced the axial plane 12 and turned to the side face. The edge of these edges 44 and 46 is bending partial 44a which has bent in the direction of an axial plane 12, respectively. And 46a It contains. Furthermore, these bending parts become the front face which realizes multiplication of the beginning of a photoelectron here. Therefore, these act as a dynode of the beginning of the photomultiplier tube.

[0021] As shown in the example of drawing 1 , a plate 32 is closely alike and the bar 52 of a small cross section is arranged on an axial plane 12. This bar can give the potential near the potential of photoelectric cathode. Therefore, this bar 52 is useful to acquiring the suitable electric field for specifying distribution of a photoelectron in the both sides of an axial plane 12. Similarly, although another bar 53 is located in the midpoint of an electrode 60 as well as a bar 52, it is perpendicular to an axial plane 12. Bars 52 and 53 are connected electrically. This bar 53 is located in parallel with separating slightly with a plate 32 and insulating with this. This bar 53 generates distribution of electric field parallel to an axial plane 12, and has the operation to which it is made for a photoelectron to be distributed over a pore 38 or either of 39 according to the location at the time of a photoelectron injecting from photoelectric cathode. This bar 53 of another has the operation to which it is made for a photoelectron to be distributed over a pore 40 or either of 41 according to the location at the time of a photoelectron injecting from photoelectric cathode.

[0022] As shown in the example of drawing 1 and drawing 2 , it has the edge 35 located at right angles [the plate 32 of an electrode] to an axial plane 12. These edges have the upward edge 34 and height lower than the height of 36. Therefore, suitable electric field to distribute a photoelectron all over the both sides of an axial plane 12 are realized.

[0023] You may be other configurations although the aforementioned example explained the bar as an even strip. For example, it is 52a to drawing 3 . It carries out, and V typeface bends along the die-length direction, and as shown, it may be located so that the base may point out the direction of photoelectric cathode.

[0024] Other modification of the description of this invention is easy for this contractor, and these modification is included in the range of this invention.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] Drawing 1 is the fragmentary sectional view of the 1st example of the photomultiplier tube by this invention.

[Drawing 2] Drawing 2 is the perspective drawing showing the assembled-die 4 path photomultiplier tube which are other examples of this invention.

[Drawing 3] Drawing 3 is the perspective drawing showing the complete-change form of the bar used by this invention.

[Description of Notations]

1 Photomultiplier Tube

10 20 Photoelectron multiplication machine

12 Axial Plane

15 Envelope of Seal Mold

16 Front Face of Envelope of Seal Mold

17 Photoelectric Cathode

22 Electron Multiplier

24 Dynode

26 28 Anode plate

30 60 Electrode

32 Plate

34 36 Wall surface

38, 39, 40, 41 Pore

42 Grid

44 46 Edge suitable for a side face

44a, 46a Bending part

48 Central Septum

49 Another Septum

50 Rising Edge

52 52a Bar

53 Another Bar

54 The First One Multiplication Path

55 Path of Secondary Electron

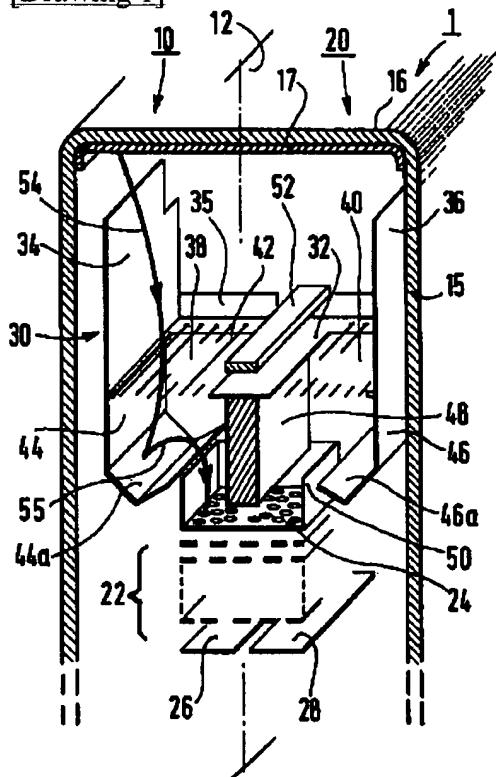
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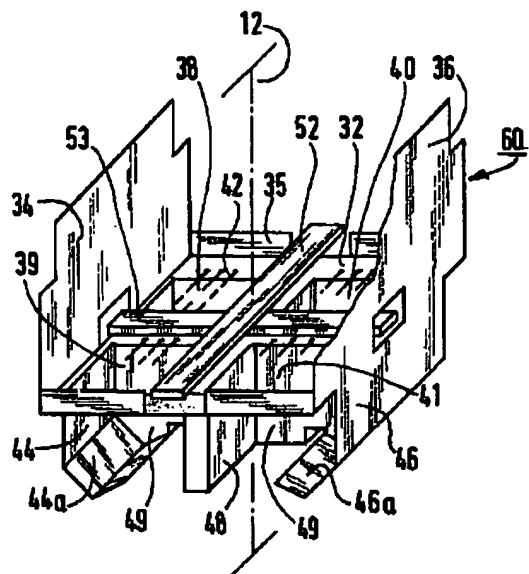
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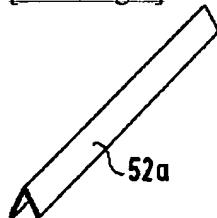
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DRAWINGS

[Drawing 1]**[Drawing 2]**



[Drawing 3]



[Translation done.]